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DEVELOPING A FRAMEWORK FOR JOINT MOBILITY ANALYSIS

A White Paper

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SUMMARY

On 26-27 September 1995, MORS held the first of a series of Workshops focused on the status and future of joint analysis. The topic of the conference was "Developing a Framework for Joint Mobility Analysis." This paper presents the results of that conference.

The Workshop devoted two days to the examination of the topic of Strategic Mobility. Its purpose was to develop a framework for analysis of mobility issues. This framework has been developed and key elements are shown in Section 5 of this paper.

At the conclusion of the Workshop, it was clear to those assembled that the Strategic Mobility area was well supported in terms of models and simulations and an existing program of creating new and improved tools was under way. It was also noted that the existing DoD program to reduce duplication and sort through the modeling and simulation was on-track, and opportunities to pursue better integration of mobility and combat models were available.

Since MORS' area of expertise is analysis, the Workshop first approached Strategic Mobility from the standpoint of what types of analyses are required to support mobility decisions. These fell into three categories; long range planning analysis, deployment planning analysis and execution analysis. Discussion of each of these types of analyses surfaced many important issues. The specific issues can be generally categorized as technology issues, analytical issues, and policy issues.

This taxonomy just described, shaped the discussions, outcomes of the Workshop and synthesis group assessment. The 72 participants brought a wealth of knowledge and experience to the discussions. Their perspectives on the issues and types of analyses were a function of whether the participant spoke as an operator, model developer, or analyst.

The framework for Joint Mobility Analysis discussed in this paper has taken into account changes in contingency planning, the computing environment and budget contract and is a direct result of these discussions.

1 INTRODUCTION

1.1 Motivation

At the final session of the JROC Workshop held on 28 November 1994, Admiral Owens, Vice Chairman Joint Chiefs of Staff, expressed his appreciation to the MORS community, but also issued the following challenge:

> *How can we best envision what the warfare environment will be in 2002? And what could the impact on doctrine be of fielding our emerging capabilities? How can we be creative in our analytical techniques that support the complex budget decisions that will get us there? In this regard, I caution the analytical community against an over reliance on historical data and to avoid measuring tomorrow's warfighting capabilities by fighting yesterday's war. We need new perspectives, analytic approaches, and models — the MORS community could be key in generating them.*

1.2 Background

Mobility analysts have applied the tools of operations research to the study of transportation requirements and capabilities for over 20 years. Senior decision makers in the Department of Defense (DoD) have used these analyses to make informed investment decisions and plan and execute force deployment operations. In exercise and operations planning, mobility analysis has been used to prepare efficient schedules for the transport of forces and material. In program planning, analysis has been used to identify high-leverage investments to improve capabilities in airlift, sealift and prepositioning.

The objectives of analysis in mobility planning are much the same today as they were 10 or 20 years ago, but both the computing environment and contingency planning have changed dramatically. Today, operations planning must contend with a wide range of possible contingencies, from relief missions to major regional conflicts. Mobility forces must be prepared to support contingencies that can develop very rapidly virtually anywhere on the globe. Investment planners must contend with increasing budget constraints while maintaining the ability to respond to these wide-ranging contingencies. As a result, the demands for computing support have increased, as has the requirement for analysis, often under very tight schedules.

The story of increases in computing capabilities is well documented in the popular press and academic literature. In the area of transportation planning, we have used new capabilities both to reduce the cost of operations and to improve capabilities. With the help of the Defense Modeling and Simulation Office (DMSO) and the Defense Advanced Research Projects Agency (DARPA), the transportation community has demonstrated that computer models used to study different aspects of the mobility system can be moved from mainframe computers to workstations and operated from common data sources. Additionally, DARPA has demonstrated the value of distributed computing to foster cooperation and collaborative planning, thus

opening the door to greater sharing of algorithms and data as well as offering new opportunities for quality control.

Determining efficient uses of the transportation system to support the rapid deployment and employment of forces would benefit from a closer link between mobility and combat analysis. Mobility analysis and combat analysis are linked in many ways. Strategic mobility is a key input to combat models because the performance of the transportation system is a major determinant of the timing of forces available to theater commanders. Similarly, tactical mobility is an important factor in determining speed of movement to maneuver units as well as resupply rates for combat units. Combat models also provide inputs to mobility analysis. Combat analysis determines the number and types of forces needed in each phase of the battle. For instance, combat models can be used to define the tactical lift problem because it is the scheme of maneuvers that determines tactical lift requirements (both for unit movement and for the supporting supply system).

It is not always obvious how to sort out the complex set of interactions between combat analysis and supporting mobility analysis. Sometimes it is accomplished in the assumptions of the study or analysis, but more complex allocation topics are often left unaddressed. Today, analyses of both strategic and tactical mobility make use of combat analysis and transportation models, but the use of these models is sequential and there are often long, involved steps in the analysis that are not automated. At the very least, it is important that future models facilitate the transfer of information between mobility and combat analyses. Tools that fully integrate combat and mo-

bility (or combat and logistics) would be a significant improvement over today's capabilities.

1.3 Understanding the Problem

The problems currently encountered in strategic mobility analyses are manifested in three specific areas. First, is the current practice of conducting mobility analysis in pockets or stovepipes, without a joint perspective. Even though Strategic Mobility is represented and characterized by an entire end-to-end process and mobility analysis is a cross-cutting area, many disparate offices need estimates of transportation capabilities in order to carry out their responsibilities. In times of unlimited budgets, individual offices and services tended to perform specific analyses and make their own decisions without regard to a joint perspective.

Second, technological advances have meant that tremendous progress is being made in mobility models and in the computing environment. But with these advancements have come problems. Mobility models are often "customized" to operate on existing hardware and operating systems, or to fit an organization's view of the mobility system. Computing environments vary greatly and it is often complicated to move computer models and data support systems from one agency to another. It is also recognized that there is an extensive amount of work being done throughout DoD on automated information support and many express a concern that the work is not well coordinated and disciplined. As a result, senior military and civilian leaders are concerned that there is more duplication of effort than is warranted.

Third, there are an interesting range of problems to address within the mobility arena. Some require very detailed information about the transportation system while others require only a high-level characterization of deployment capabilities. While there is a considerable amount of duplication in the work that has been done over the past five years, there is also a large amount of work that is complementary. As we look to the future, it seems reasonable to sort through the alternative efforts and draw heavily on the modeling techniques and data structures that have proved most effective.

1.4 Purpose of the Paper

This paper will describe the purposes of strategic mobility analysis (or the decisions it supports), organize the major strategic mobility analysis issues as determined by the participants of the workshop and provide a framework for analysis of the strategic mobility area. It offers suggestions for near-term improvements and demonstration projects, and a proposed plan that can be used to support both operations planning and investment decisions.

2 APPROACH

2.1 Objectives

The objectives of the Workshop were to:

1. Develop a framework for joint mobility analysis, which focuses on methods to evaluate mobility requirements and programs in the context of future warfare environments.

2. Determine the state of the art in mobility analysis and modeling and how recent and potential advances in computing environments might be exploited to support future mobility investment decisions.

2.2 Methodology

The Terms of Reference (TOR) (see Appendix C) for this Workshop was approved and supported by all MORS Sponsors. The Workshop was held at the MITRE Corporation headquarters in McLean, Virginia 27, 28 September 1995. Seventy-two members of the mobility and analysis community attended, and participated in the sessions. They represented various Government agencies, contractors, and academia. Mr. Jim Johnson, Director of Projection Forces, Office of the Secretary of Defense for Program Analysis and Evaluation, Chaired the Workshop.

The meeting agenda included the presentation of 14 papers, discussion periods, and three separate discussion groups and their reports. The Workshop participants heard and discussed papers on mobility models, mobility analysis, and improvements in computing that are designed to support

object-oriented programming and distributed computing. Also presented were the results of a service-sponsored meeting on mobility. Several questions (listed in the TOR) were to be addressed during the discussion. Participants were charged with considering the following specific aspects of joint mobility analysis:

- Status of current joint mobility analysis in operational context;

- Analysis of mobility support for future warfare;

- Technical aspects of mobility modeling; and,

- Role of emerging computing environments.

These challenges were amplified by Mr. Johnson who added that mobility analysis must address:

- A description of an end-to-end process;

- Inter-theater vs intra-theater interactions;

- Scheduling of mobility assets in accordance with strategy;

- Force flows synchronized around strategy;

- Timing of events important to strategy; and,

- Air Port of Embarcation (APOE)/Sea Port of Embarcation (SPOE) decisions impacting upon strategy and force flow.

2.3 Organization

Three working groups met on the second day to consider joint mobility analysis from three perspectives. The three working groups and the leaders were:

WG 1. What are the requirements for decision support systems? Leaders, Dr. Roy Rice and Mr. Rob Ewart

WG 2. What new procedures are needed, what new capabilities in modeling and simulation are needed to support the procedures? Leaders, Mr. Bill Cooper and Mr. Mart Lidy.

WG 3. How can the mobility community make the best use of the new High Level Architecture to support JAMIP? Leader, Mr. Denis Clements.

A synthesis group was added subsequent to the meeting to collect, organize and summarize the large amount of information presented during the two days. The synthesis group was composed of Dr. Jackie Henningsen (MORS VP-PA), Mr. Brian McEnany (MORS Past President) and Dr. Roy Rice, Working Group 1 chair.

3   CURRENT STATE OF THE ART

3.1   Organization of the Approach

The gathering of information from various agencies and community perspectives provided the raw data needed to understand and organize the major strategic mobility analysis issues and to begin the development of a framework for joint analysis of the strategic mobility area. The presentations by the participants offered a current picture of the strategic mobility analysis area and allowed the participants to better frame the discussions of the working group and follow-on synthesis group. The approach taken by the synthesis group was to: (1) identify, from the data gathered, the types of analysis performed or decisions that mobility analysis must support; (2) identify the major issues that apply to these types or categories of analyses and decisions supported; and, (3) identify the major players or perspectives of the major players in the strategic mobility analysis arena.

3.2   CINC Input

General H. T. Johnson (USAF, Ret), former Commander-in-Chief US Transportation Command (CINC USTRANSCOM), started the conference with a stimulating keynote address based on his experiences in Operations Desert Shield and Desert Storm. His remarks provided a CINC perspective, bringing into clear focus the immense challenges that he and the US-TRANSCOM staff faced during the deployment. Operation Desert Shield was the first test of the automated systems for deployment execution that were designed in the 1980s. General Johnson's comments made it clear that automated support is essential, but that considerable improvements can be made in the quality of these systems. He emphasized the importance of training and the flexibility of user-friendliness of systems so that more of the people involved in deployment planning and execution can make use of the tools. He noted that the superb efforts of a highly qualified staff completed the deployment successfully, despite the limitations of the automated planning systems. Improvements in the automated systems used to support deployment planning and execution are certainly justified given the experiences during Operation Desert Shield.

General Johnson identified several important lessons learned and issues that affect supporting strategic mobility analyses:

- Need to know what effect changes in the ongoing flow have to force and supply arrivals in theater.

  ➢ Limited automated predictive capability exists

- The Joint Operational Planning and Evaluation System (JOPES).

- Need for well trained personnel to provide inputs and work the Automated Manning System (or its replacement).

- Need for personnel to train with the system in peacetime as well as wartime.

  ➢ JOPES did not support training use to any great degree prior to Desert Shield

- ➤ Training insufficient to maintain proficiency needed during wartime

- Need to be able to work on "chunks of data."

  - ➤ Must be able to excise portions of Time Phased Force Deployment List (TPFDL) for separate analysis during planning and execution

- Data acquisition was a big problem during each crisis event over last ten to fifteen years.

- JOPES is very process oriented.

- JOPES has limitations.

  - ➤ Saturates very quickly

  - ➤ Is not user friendly

  - ➤ Is very slow, lacks trained operators when you need them

  - ➤ Important to re-validate the TPFDL quickly during crisis events

3.3 Related Mobility Analysis Programs

Besides the operational perspective discussed, there are several initiatives and activities ongoing in the joint mobility analysis community. The following were presented and discussed at the Workshop.

3.3.1 Joint Analytic Model Improvement Program (JAMIP) Program.

To stimulate discussions from a modeling and model development perspective, a view of automated decision support and analysis systems was provided by Dr. William Lese in a presentation of the JAMIP. Initiated by the Deputy Secretary of Defense in February 1995 and approved in May 1995, the JAMIP program is intended to upgrade existing joint analytic models and simulations in the near-term and develop a set of next-generation models in the longer-term. JAMIP will also include a joint data support system providing the first DoD-wide analytic database. These improvements are intended to improve the support to senior decision makers in terms of long range analyses (investments in modernization, force structure, readiness, training, mobilization, and logistics). It will also support deployment planning analysis by facilitating the development of CINC operations plans from an integrated, joint operational perspective. It was noted that one slide in Dr. Lese's briefing showed a state of knowledge about multiple functional areas. The strategic mobility function was assessed as Green, indicating that a large amount of information was present and M&S work was adequate.

Dr. Lese identified the current status of the JAMIP program as follows:

- Prong 1 activities with TACWAR, VIC, EADSIM, ITEM, MIDAS, SUMMITS identified as core joint models.

- Areas of concern that must be addressed in joint analysis of mobility.

  - ➤ End-to-end process description

    - ◆ APOE/SPOE Mobilization/ Strategic Mobility assets and strategy.

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- APOD/SPOD Reception, Selection, Onward Movement

  - RSOI Prepositioned asset utilization as part of strategy

  - Tactical deployments intra-theater

  - WMD usage and interruptions to force flow

  - Need for certified data to feed various functional areas

  - Need to describe joint doctrine and ability to change it

  - Need to consider C4ISR issues

  - Designed for 4 major users (CINC, Services, JCS, OSD)

  - Currently investigating mission space with Joint Requirements Committee led by Joint Staff/J-8

- Challenges include:

  - C4ISR

  - Linkage to the Joint Simulations System

- Features included:

  - Level of resolution for joint simulation and analysis

- Use of national labs to assist in model variability, determine key factors, prioritize key factors.

- Planned establishment of a Joint Warfighting System (JWARS) Office

to develop a future model of Joint Warfare

3.2.2 USTRANSCOM/TEA - Force Projection Model (FPM).

USTRANSCOM/TEA, detailed a modeling and model development effort from a perspective outside the beltway. The FPM Program was well laid out and identified most of the current areas of interest within the community. It addressed the development and use of several models and simulations that mirrored the mobility deployment picture. The process, shown graphically, began with mobilization and movement to CONUS facilities; movement to APOE/SPOEs, movement between POE/PODs, arrival at APOD/SPOD, onward movement into the tactical theater of operations (intra-theater movements). The FPM has developed a set of M&S that mirrors this process. TRANSCAP at installation; ICODES/ALM/PORTSIM CONUS ELIST at POE level; JFAST/MIDAS at deployment level; ICODES/ALM/PORTSIM ELIST at POD level; TARGET/DART at requirement level to re-order TPFDL elements. Others (CONUS ELIST, SMART BRIDGE).

The FPM is designed to evaluate interaction of infrastructure and transport system with detailed transportability characteristics of the deploying force. Advanced simulation capabilities were partially addressed. PORTSIM provides a three-dimensional view of port capabilities. It can be configured to address air or sea POE. A demonstration was shown at Ft Hood, TX and Charleston, SC. Visualization of the process appeared to be important to mobility community and it has been developed as a prototype.

The conclusions drawn from these discussions are that the mobility problem is very process oriented, FPM currently does not contain detailed models of ports or facilities, and does not have LIN level tracking capability.

3.3.3 US Army's Concepts Analysis Agency (CAA) - Global Deployment Analysis System (GDAS).

Dr. Abbe of CAA discussed the current status of GDAS. This program was recently developed and used by the Army to analyze deployment issues. It includes input from mobilization simulation under development (MOBCEM) and has good visibility over major assets during mobilization. It does provide limited input into CAAs' conflict M&S. Some general observations are that it can be used to examine RSOI issues. It had recently been used in an analysis of a Korean deployment, but the data requirements were heavy and required Level 4 JOPES data. GDAS also uses detailed TPFDL information and inputs.

3.3.4 Joint Staff - JCS/J4 - Force Deployment Estimator (FDE).

The Joint Staff presented FDE- as rapid adjunct to JFAST and MIDAS. It is a clever combination of goal programming and simulated annealing and offers a way to approach the problem of rapid estimates, given changes in current force flows. It is a powerful tool in the long range analysis and deployment analysis areas.

3.3.5 ARPA/TEA Logistic Anchor Desk Program (Mr. Seaman - TEA)

Program objectives were to provide visibility of assets during deployment,

optimize defense transportation system, use 2010 as objective end state and develop real time operational planning tools

3.4 Other Related Activities/ Organizations

3.4.1 JROC Strategic Mobility Working Group.

A working group that was established out of the Expanded JROC examination has been actively examining the Strategic Mobility area for some time. Strategic Mobility and its Protection Joint Warfighting Capability Assessment (JWCA) was organized to meet the requirements of the JROC. A MORS Workshop "Joint Requirements Oversight Council Process" was held 17-18 October 1995, in Arlington, Virginia. Within that Workshop, the members of the Strategic Mobility/JWCA working group prepared a near term study plan and identified 19 separate issues in this area. Four issues were deemed critical from their perspective as they apply to long range analysis and deployment analysis:

1. The identification of future forces to be moved.

2. The threat to strategic mobility forces.

3. The strategic mobility analysis MOO/MOEs.

4. The huge data requirements for strategic mobility analyses.

In addition, several observations were made during the JROC session:

- The MRS BURU was the foundation for strategic mobility.

- 19 separate issues were examined and included in current study plan for the area.

- No study methodologies were discussed during the session due to time constraints.

- A long term plan was needed.

- A plan for gaining data for the next MRS Bottom-Up Review Update (BURU) was needed.

Recommendations from the working group suggested that the J4 develop a procedure to insure that all services regularly update the MRS BURU data bases. Other pertinent comments were included in the MORS Proceedings, dated 27 February 1996.

3.4.2 Mobility Conference Inputs

Dr. Yupo Chan of the Air Force Institute of Technology (AFIT) presented several key issues identified at the recent Third Mobility Simulation Users Group Meeting. The research issues discussed by the group included the following areas:

- Stochastic facility locations;

- Terminal operations;

- Modal share analysis;

- Run time information; and,

- Spatial gaming analysis of campaign.

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4   ASSESSMENT OF STRATEGIC MOBILITY AREA

4.1   Working Group Discussion/ Results.

Once the participants had presented their major issues impacting the different types of strategic mobility analyses from their perspectives, three working groups were formed to deal with specific details.

Working Group 1: What are the needs (requirements) of the strategic mobility analysis community, the specific questions being asked, and decisions being supported? *(Roy Rice, Rob Ewart).*

To address the many questions asked of mobility analysts in the three distinct areas of long range analysis, deployment planning analysis and execution analysis, this group focused on specific decisions and processes that must be supported. Long range analysis involves the OSD and Joint Staffs, the Services and the CINCs and must address questions related to investment planning and long-range strategies. Deployment planning analysis includes mid-term strategy and plans for theater deployments. Execution analysis is generally carried out by the Joint Staff, CINCs and Services. Execution analysis must balance the conflicting demands of total asset visibility with quick-turn decision support tools. It also has the interesting challenge of supporting real-time operations. Underlying all three parts of the planning process is the need for accurate data describing the forces to be moved, the transportation networks and infrastructure and the transportation assets.

Working Group 2: Definitions and procedures for simulation and modeling to support a joint framework for analysis. *(Mart Lidy, Bill Cooper).*

Given that Working Group 1 can determine the requirements of the mobility analysis community, Working Group 2 focused on the purpose of the models we plan to develop as well as a number of capabilities that should be integrated, particularly if the objective is to support wargaming. First regarding the purpose of the models, it was clear that the development should set clear objectives and not fall into the failure of trying to be all things to all people. While there are numerous ties between models and data used to support the range of questions raised within DoD (see the taxonomy produced by the first group), decision support systems are not structured precisely the same way as systems for analysis. Suggestions to work hard on data standardization to foster cooperation in sharing models and data appear to be one way of managing the complexity. A number of areas are simply absent from many mobility models in use today. Reception, Staging, Onward Movement, and Integration (RSOI) provided one of the best examples of an area that needs firm definitions of terms, joint doctrine and needs to be included in future mobility models.

Working Group 3: Use of the High Level Architecture (HLA) to support JAMIP *(Denis Clements)*

Common Object Request Broker Architecture (CORBA) is one way of managing complex models and data structures. In-

dustry is developing tools exploiting CORBA and DoD is working toward a definition of a HLA that will provide the standards for combining models into a joint simulation. This technology has the possibility of improving the design and management of single-implementation computer models as well as supporting distributed computing so that mobility computations can take advantage of computer code and data that are maintained in distinct locations in the US and overseas. It will be important for the mobility community to follow the development of HLA as well as the innovative ideas introduced by the computing industry.

The challenge for modeling and analysis that has been set in the JAMIP program is formidable. Fortunately, the mobility community has a long history of solving complex problems. Furthermore, the computing environment emerging in the US industry is capable of supporting cooperation in model development, supporting data, and analysis on levels needed to solve the complex problems facing decision makers today. JAMIP should provide a disciplined approach to data management, model development and analysis that will facilitate the cooperation needed for its success.

4.2 Synthesis Group Approach

The Synthesis Group attempted to collect, organize and analyze the large quantity of information presented during the Workshop. The results of discussions within the three working groups were used to start the analysis process. In addition, the group believed that the success of the Workshop hinged on whether answers to the following questions were possible:

- What is being done in the strategic mobility area today?

- What is the strategic mobility process?

  - What do we know about the process?

  - What do we not know about the process?

- What is truly joint about the elements of the process?

- Where are the threads that can be defined that affect warfighting for strategic mobility?

- What is broken in existing process?

- What is working right?

4.2.1 Decisions Supported by Strategic Mobility Analysis

Working Group 1 began the organization of information from the Workshop participants concerning the state of strategic mobility analysis. The working group determined that there are three types of mobility decisions and supporting analyses. They can be categorized as (1) analyses supporting long range investment and force structure decisions; (2) analyses supporting deployment planning decisions; and, (3) analyses supporting deployment execution decisions. Based on working group discussion and presentation, the synthesis group described each in more detail below.

Long range investment and force structure decisions: These are decisions and processes that are supported by analyses such as the Mobility Requirements Study (MRS),

the BURU, COEAs, MNSs, ORDs, JMNA, and CPA/CPR. Analyses conducted to support these decisions are generally large scale studies over several months focusing on a long term horizon. They answer questions about funding resource allocations and force mixes. These will be referred to as *long range analyses*.

Deployment planning decisions: These are decisions that are supported by analyses of TPFDD development and CINC OPLAN/CONPLAN concept comparisons and tradeoffs. Analyses conducted to support these decisions are generally data intensive, very detailed and have more of a mid-term sense of urgency. They answer questions about transportation assets allocations and flows of commodities (personnel, equipment, units, combat support, etc.). These will be referred to as *deployment planning analyses*.

Deployment execution decisions: These are decisions that are supported by analyses addressing near-real time issues. In general, the analysis is conducted with on-line or near real time decision support tools. These analyses and tools are data intensive, as well as communication intensive.

The analyses help solve real transportation and support questions as they occur during execution of various operations and herein will be referred to as *execution analyses*.

4.2.2 Identification of Major Issues Impacting the Analyses

Once the types of strategic mobility decisions and supporting analyses were understood and categorized as just described, it was logical to define issues impacting these types of analyses. Many of the issues apply too more than one of the categories of

analyses. For instance, during the workshop one of the prevalent issues impacting strategic mobility analyses was data availability/access. Data availability/access applies to all three types of analyses. Figure 1 depicts a matrix of types of analyses and issues. Specific issues are categorized and each is addressed later in this paper. Based upon working group discussions and the lists of questions or issues provided during the conference by the participants, the issues appeared to fall into groups that can be labeled (1) technology issues; (2) analytical issues; and, (3) policy issues.

Figure 1. Types of analyses vs. issues

4.2.3 Users and Perspectives of the Major Players

Finally, the results of the Workshop allowed the synthesis group to suggest that the three types of analyses can also be viewed from the perspective of the major players in strategic mobility community. Therefore, the identification of the major players and their perspectives were categorized as (1) operational; (2) modeling and model development; and, (3) analysts. Figure 2 shows the possible relationship of the types of analyses, the types of issues and users of analysis.
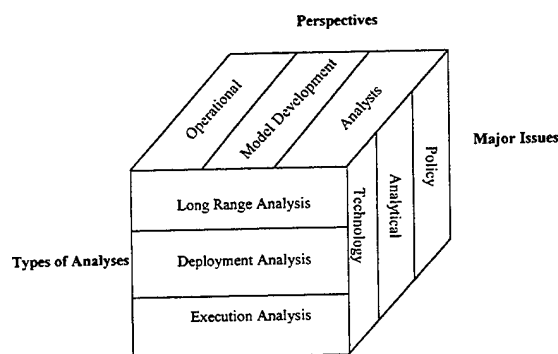
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Figure 2. Relationship of the Three Factors

The Synthesis Group collected all the major issues discussed at the Workshop and attempted to organize them in different ways. One approach used the "cube" in Figure 2 that shows the relationships among the major issues, players' perspectives and types of analysis. A second approach began with a listing of all issues generated during the workshop.

4.3 Taxonomy of the Various Decisions, Analyses and Issues

The synthesis group developed a listing of all issues and questions raised during the Workshop. By progressively and judgmentally assigning the various issues and questions to various categories, relationships among the various issues began to emerge.

4.4 Final Workshop Assessment

In the case of strategic mobility analysis, the process, as stated in our assessment earlier, is well understood. It can be represented as a true end-to-end process. The community appears to be saying that the portion of the process between mobilization and RSOI is understood and being addressed in current and projected mobility M&S programs (AMP program).

In the case of this Workshop, after the discussions about how things are done in strategic mobility analysis, Working Group 1 determined the requirements of analysis in this area. They focused on *decisions* and decision makers that require analytical support, *processes* that involve analysis, and *products* that require analytical underpinnings.

To fully understand the requirements, a collaborative approach is essential. This Workshop needed the depth and range of knowledge and experience of all the participants so we could uncover the wide range of issues from various perspectives and apply them to the critical types of analyses in the community.

The challenge for improving analysis within DoD goes beyond the task of consolidation and removing duplication. An equally difficult aspect of improving analysis is the integration of mobility and combat models. Meeting this objective for JAMIP requires a detailed understanding of both combat and logistics.

The community is saying that RSOI is not well understood and direct linkages to warfighting capability exists in this segment of the end-to-end process.

Depending upon whether the JWCA definition of the area or Workshop definitions are used, the threat to the mobility assets themselves could be considered to be linked to warfighting capability. Threat and friendly forces must protect the mobility links, requiring the allocation of protection forces to that mission during deployment.

The front segment of the mobility process (mobilization of forces) is not well under-

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stood. Currently, US Army CAA is developing a capability to address Army mobilization with MOBCEM. It is linked to GDAS, another CAA movement model, but must be linked to movement of forces to and from installations.

The one clear issue that all agreed is essential was the availability and access to certified or correct data to support execution and deployment analyses. The criticality of updating or acquiring current data during execution analyses is limited by lack of consistent data across services. The criticality decreases as the time horizon expands and more time is available to acquire the data needed to support long range or deployment decisions.

4.5 Key Questions to Consider When Developing New Models

The participants in the conference raised a number of more specific questions and issues that should be addressed as we move toward a new set of models, particularly if the objective is to develop models and analysis procedures that will benefit the mobility community in general. Issues were discussed during the working group sessions and suggested during the general discussion during and after presentations. As usual, the conference participants put the meat on the bones of the more general questions that motivated the Workshop. The questions listed below deserve increased attention.

- What level of detail is appropriate in the conduct of mobility analysis and is the current TPFDD format adequate to portray the required information?

  - Cargo categories (TPFDD Level 3) vs Line Item (TPFDD Level 4)

  - Lift assets (track individual aircraft? truck/rail?)

  - Ports/nodes/facilities (100, 1000, or 10,000)

  - Level of detail in modeling infrastructure

  - Time (daily? hourly?)

- What are the long range analysis questions to be answered?

  - If it is "value of adding cranes," need port details.

  - If it is "port throughput backlogs," need individual ports (>1000).

  - If it is "C-17 vs C-5," need detailed aircraft characteristics.

  - If it is MOG, need hourly detail.

  - If it is investment, need costs.

- How do we integrate databases?

  - JAMIP, MTMC/TEA, JOPES, GTN, Logical Transportation Database Design (LTDB)

  - Database normalization and generalization to allow new cargo categories rail, road, etc.)

  - Multi-platform

- Do we need a strategy for use of multiple platforms in mobility analysis? (Sun, HP 9000, PC/Windows)

- Do we need linked dependent force arrivals in the conduct of mobility analysis?

- What are the key "threads" that are important to other parts of joint analysis? What is important in this topic area that affects/drives/inputs to warfighting? Are we missing something important such as RSOI and mobilization activities in our analyses?

5 FRAMEWORK FOR JOINT MOBILITY ANALYSIS

A framework for analysis is difficult to prepare when existing procedures for the conduct of joint analysis do not exist. The Joint Staff, through its Nimble Dancer series of wargames, have established the concept of "collaborative analysis" as an important part in the examination of specific functional areas. This concept should be considered as part of an analytic framework that includes strategic mobility. Based on the evaluation conducted during this workshop, there are some steps that can be taken to begin the process of establishing a framework for joint mobility analysis. The strategic mobility analysis framework must address all facets of movement from mobilization of reserve forces, through mobilization stations, to SPOE/APOE to APOD/SPOD, and include RSOI.

Step 1: Determine issues and potential paths to solution from working group discussions and synthesis of issues in this white paper.

- Clarification of data issues for operating agencies to satisfy deployment planning and execution analyses.

- Update databases to reflect MRS BURU requirements for long range analyses.

- Create taxonomy of joint mobility terms that can be used throughout DoD mobility community. Expand upon the IDA effort underway.

- Determine if establishing joint line items will sufficiently cause more availability of data among operating agencies, thereby reducing criticality of data for time dependent analyses.

Step 2: Determine key factors or threads affecting combat processes.

- Begin to create threads that link joint forces to mobility process.

- Identify mobility factors that affect joint analysis.

- Identify linkages by expanding upon existing work done with JWARS functional work groups and add mobility and analytic community participants to assist in defining threads between two functional areas. (Need to expand upon the current deficiency within representation of the RSOI end point in deployment process to the force supply points directly affecting execution of campaign strategy.)

- Align time periods between mobility analyses and combat analyses.

- Ensure that level of detail for RSOI output matches input requirements for combat analyses.

Step 3. Link Deployment Analysis level mobility analysis to combat process to ensure terminology and processes are linked correctly

- Establish predictive capability if flow is interrupted.

- Insert mode/node change requirements into process.

- Ensure that threat to mobility forces is included in analysis of process.

- Include forward and reverse flow in analysis of campaign requirements.

- Add reconstitution of forces into mobility analysis and campaign analyses subsequent to achievement of theater objectives.

Step 4. Test long range deployment analyses with MRC campaign effort.

6   PROPOSED FRAMEWORK ACTION PLAN

Following the Workshop, a tentative plan for proposed actions was developed. Several of these actions have been on-going since the Workshop.

1. Continue to follow improvements in computing. The computing environment envisioned for the High Level Architecture could offer a dimension in modeling and analysis that is not available anywhere today. More complex operating systems that support CORBA may facilitate the rapid design and execution of experiments.

2. Make use of improvements made to date. Computing capability is already dramatically better today than it was five years ago, yet many of the procedures for conducting analyses have not changed for decades. At the very least, we can use today's technology to increase the sharing of data and analysis models.

3. Begin the process of defining a common set of objects to be used in mobility analysis and combat analysis. This should probably start as a "data" exercise focusing on the data structures needed to support both types of analysis. It could quickly evolve to an object oriented analysis of combat and logistics.

4. Conduct experiments with PA&E, TRANSCOM, and MTMC to combine data and models. Two specific areas are:

   a) Using distributed computing to evaluate the cargo to be moved; and,

   b) Using distributed computing to compare aggregate and detailed representations of aspects of the mobility system.

5. Based on the results of the prototype and other work accomplished in mobility analysis, prepare an action plan that coordinates the work of DoD offices supporting mobility models for JAMIP and JSIMS.

APPENDIX A: ISSUES AND QUESTIONS THAT DO NOT FIT INTO ASSESSMENT

A.1 ISSUES: TECHNOLOGY

1. Need to display location and status of assets during deployment and re-deployment.

2. Need single point entry for all data.

3. Need rapid scenario generation capability.

4. Need rapid TPFDD generation (hours).

5. Need to have consistency in model hierarchy. Models at different levels of fidelity that feed each other must use the same assumptions and basic approaches.

6. Need to be able to access data on remote APOD/SPODs and transportation infrastructure through out the process to the foxhole. RSOI is of major concern.

7. Need to be able to access municipal/state/federal transportation infrastructure data.

8. Need well defined, useable procedures (JOPES, JDS,...). These standard procedures and tools must be able to interface with the tools we build for specific applications.

9. Need to have Total Asset Visibility (TAV) on most classes of supply, units, personnel and intra-theater lift assets.

10. Need real time, constant communication to G-4/S-4 staffs.

11. Need to be able to access data on transportation networks in terms of capacities and usability. Graphical Information Systems (GISs) have tremendous potential.

12. Need to be able to access Estimated Time of Arrival (ETA) of assets en-route from the CONUS.

TECHNOLOGY PERSPECTIVE

	Operational	Modeling	Analyst
Long Range	1,3,5,6,7,8, 9,11,12	3,4,5,6,7,8, 9,11,12	3,4,5,6,7,8, 9
Deployment	1,2,7,8,10,	2,7,8,10,13	5,6,7,8,10
Execution	2,11,12	2,7,11,12	11,12

ASSESSMENT

Technology offers the possibility of working towards solutions in the following:

- There is clearly a need for single entry point for all data across all users (2);

- Non-time critical needs are reflected in long range and deployment analyses only (2,3,5,6,7); and,

- There is a need to access data on remote APOD/SPOD and infrastructure across deployment and execution analyses (6).

A.2 ISSUES: ANALYTICAL

1. Need for predictive capability.

2. Need to have start and stop capability with flow.

3. Need to be able to trade-off lift assets (air and sea) prepositioned between and within each category.

4. Need to be able to model the end-to-end process (home-foxhole-reconstitute).

5. Need to be able to connect mobility analysis to operations (OOTW through combat) to show the impact of lift on operations.

6. Need to be able to connect operations to mobility analysis to show how changes in operations (doctrine, strategies and objectives) impact lift requirements.

7. Need to be able to access variable resolution data (fidelity) from "how much does an armored division weigh?" to "how many/where tie down points are in a C-5?"

    • Need to be able to access joint data (force, mobility, and logistics). Service analysts must have access to other services' data ... and must be able to interpret it.

    • Need to be able to access combined data (force, mobility and logistics).

    • Need to be able to share data rapidly between organizations.

8. Need to be able to model force deployment, sustainment, logistics.

9. Need to be able to access notional TPFDDs for analysis purposes and not spend valuable time arguing about the "predictive" nature of actual deployments and operations.

10. Need to be able to account for multi-direction, multi-modal, multi-commodity nature of inter- and intra-theater mobility analysis. Various types of cargo may be transiting through the same nodes going in different directions on different lift assets.

11. Need to be able to model and account for Host Nation Support.

12. Need to be able to include infrastructure in our analyses. Sometimes it might be more cost effective to invest in refueling hydrants than more aircraft.

13. Need to be able to schedule lift assets (optimality). Scheduling is crucial.

14. Need to be able to define early arrival requirements (MHE, early entry, RSOI).

15. Need strong connection of the intra-theater and inter-theater lift systems with visibility into both.

16. Need to be able to account for 2-way direction of transportation to include evacuation of units, people, NEO, spares, etc.

17. Need to be able to account for ongoing operations. Naval operations from SPODs and combat air operations from APODs must be ac-

counted for in the execution of mobility processes.

ANALYSIS PERSPECTIVE

	Operational	Modeling	Analyst
Long Range	1, 3, 5, 6, 7, 8, 9, 11, 12	3,4,5,6,7,8, 9,11,12	3, 4, 5, 6, 7, 8, 9
Deployment	1, 2, 7, 8, 10, 14, 15	2,7,8,10,13, 15	5, 6, 7, 8, 10, 13, 15
Execution	2, 11, 12, 16, 17	2,7,11,12	11, 12, 16, 17

ASSESSMENT

The Analytic Category offers:

- Long range and deployment analyses require access to joint data (7,8);

- Inclusion of functional activities other than mobility are important (HNS, infrastructure, bi-directional flows (11,12,16);

- Including ongoing activities of all services with mobility analyses is important (17); and,

- Intra-theater lift is important to deployment analyses (15).

A.3   ISSUES: POLICY

1. Need to consider re-deployment as part of all planned and execution of operations.

2. Need standard definitions of deployment elements across services.

3. Need to be striving for Decision Support tools because we are ultimately trying to assist the decision makers with making the best decisions for our country.

4. Need to be able to present analysis results in "coherent" fashion for the decision makers.

5. Need to place the emphasis on the analysts and not the tools.

6. Need to be able to access applicable models that my shop doesn't have and acquire training in their use. Collaborative analysis is a must.

7. Need to tie planning/analysis to training so our training accomplishes "validations."

8. Need to be able to train with systems that we execute with.

POLICY PERSPECTIVE

	Operational	Modeling	Analyst
Long Range	4, 5, 6	2, 4, 5, 6	2, 4, 5, 6
Deployment	1, 2, 5, 7, 8	2, 5, 8	2, 5, 7
Execution	1, 2, 7, 8	3, 8	3, 7, 8

ASSESSMENT

Policy category offers:

- There is a clear need to train with systems that we conduct deployment and execution analyses with (8);

- There is a need to place emphasis on analysis and not the tools that are used (5); and

- There is a need for standard definitions of mobility terminology (2).

APPENDIX B: ACRONYM LIST

AFIT	Air Force Institute of Technology
ALM	Air Life Loading Model
AMP	Analysis of Mobility Platform
APOE	Air Port of Embarkation
BURU	Bottom-Up Review Update
CAA	Concepts Analysis Agency (Army)
C4ISR	Command, Control, Communication, Computers, Intelligence, Surveillance, and Reconnaissance
CINC	Commander-in-Chief
CONPLAN	Concept Plan
CONUS	Continental United States
CORBA	Common Object Request Broker Architecture
DARPA	Defense Advanced Research Projects Agency
DART	Dynamic Analysis and Replanning Tool
DMSO	Defense Modeling & Simulation
DoD	Department of Defense
EADSIM	Extended Air Defense Simulation
ELIST	Enhanced Logistics Intra-theater Support Tool
ETA	Estimated Time of Arrival
FDE	Force Deployment Estimator
FPM	Force Projection Model
GDAS	Global Deployment Analysis System
GIS	Graphical Information Systems
GTN	Global Transportation Network
HLA	High Level Architecture
HNS	Host National Support
ICODES	Integrated Completion Deployment System
IDA	Institute for Defense Analysis
ITEM	Integrated Theater Engagement Model
JAMIP	Joint Analysis Model Improvement Program
JCS	Joint Chiefs of Staff
JFAST	Joint Flow Analysis System for Transportation
JOPES	Joint Operational Planning and Evaluation System
JROC	Joint Requirements Oversight Council
JWARS	Joint Warfighting System
JWCA	Joint Warfighting Capability Assessment
LIN	Line Item Number
LTDB	Logical Transportation Database Design
M&S	Modeling and Simulation
MHE	Materiel Handling Equipment
MIDAS	Model for Inter-theater Deployment by Air and Sea

MNS	Mission Needs Statement
MOBCEM	Mobilization Capabilities Evaluation Model
MOE	Methods of Effectiveness
MOG	Maximize on the Ground
MRS	Mobility Requirements Study
MTMC	Military Traffic Management Control
NEO	Noncombatant Evacuation Operation
OOTW	Operations Other Than War
OPLAN	Operational Planner
OSD	Office of the Secretary of Defense
PA&E	Program Analysis & Evaluation (Directorate)
POD	Port of Debarkation
POE	Port of Embarkation
PORTSIM	Port Simulation
RSOI	Reception Staging Onward Movement
SPOD	Sea Port of Departure
SPOE	Sea Port of Embarkation
SUMMITS	Scenarios Unrestricted Mobility Model for Intra-theater Simulation
TACWAR	Tactical War Model
TARGET	Theater Analysis and Replanning Graphical Execution Toolkit
TAV	Total Asset Visibility
TEA	Transportation Engineering Agency
TOR	Terms of Reference
TPFDL	Time Phased Force Deployment List
TPFDD	Time Phased Force Deployment Data
TRANSCAP	Transportation System Capability
TRANSCOM	Transportation Command
USTRANSCOM	US Transportation Command
VIC	Vector in Commander
WMD	Weapons of Mass Destruction

APPENDIX C: TERMS OF REFERENCE

Developing a Framework for Joint Mobility Analysis

Purpose: To provide a forum in the area of joint mobility to identify and explore new perspectives and analytic approaches to support future warfighting and budget decisions.

Introduction: At the final session for the JROC Workshop held on 28 November 1994, Admiral Owens expressed his appreciation to the MORS community, but also issued a challenge as follows:

> "How can we best envision what the warfare environment will be in 2002? And what could the impact on doctrine be of fielding our emerging capabilities? How can we be creative in our analytical techniques that support the complex budget decisions that will get us there? In this regard, I caution the analytical community against an over reliance on historical data and to avoid measuring tomorrow's warfighting capabilities by fighting yesterday's war. We need new perspectives, analytic approaches, and models — the MORS community could be key in generating them."

The Vice Chairman's questions highlight the critical need for the review and possible modernization of our analytic techniques. The MORS community should be a leader and facilitator in the identification and dissemination of this process. However, while in this process of seeking the new, it is important to caution against an over-reliance on a singular view of the future and narrow perspectives of how technology alone may master future war and conflict. Although overworked, we seek the robust not the narrow. The JROC workshop provided a vehicle to educate the MORS community about the emerging requirements for joint analysis, but a smaller, more focused forum is required to determine a strategy for reviewing and modernizing the models, tools, and methodologies to support joint warfighting analysis as it relates to the PPBS.

Discussion: This MORS Workshop "Developing a Framework for Joint Mobility Analysis" will be the first in a series of workshops focused on the status and future of the broader category of joint analysis. This workshop will provide a starting point for several key improvements that are needed in mobility analysis. The first area is to continue the efforts — begun by TRANSCOM under the Analysis of Mobility Platform (AMP) program — to build an analysis system that describes the deployment process from home station through the employment of forces in the theater of operations. Through the AMP project and the Associated Mobility Roundtable, TRANSCOM demonstrated that such a system is possible with today's computing technology. The work started by TRANSCOM is a foundation for the near term mobility component of the Joint Analysis Model Improvement Program (JAMIP).

A second area of desired improvement that the workshop will address is the establishment of a common computing environment for use by the mobility community. There are a number of simulation models that describe various aspects of the mobility system residing on a wide-range

of computing platforms from main-frame computers to DOS-based PCs to UNIX-based work-stations. While the ability to share models and data is improving, it is not always easy to move models from one office to another. The goal of initiatives such as the Defense Modeling and Simulation Office led High Level Architecture effort, should allow the community to define a set of procedures that will ease some of the system-specific constraints making it easier to share data, models, and analysis designs.

The integration of related models and improvements in computing that facilitate the sharing of data and models in the mobility community are two key components for improving the productivity of mobility analysis within the Department of Defense. They are not ends in themselves, however. Today's decision support systems do not provide the information needed to quickly produce efficient transportation schedules for rapidly developing crises. To make matters more complicated, there are many aspects of theater tactics, logistics, and mobility that are interrelated. These interactions can have a dramatic effect on the combat capabilities that may be provided early in a contingency. A sound foundation for analysis is needed before we begin to tackle the more complex interactions and represent them in our decision support systems. The Workshop is designed to build on the successes in mobility analysis, modeling, and computing to increase the quality of mobility analysis and improve the support to senior decision makers within DoD.

Objectives:

1. To develop a framework for joint mobility analysis which focuses on methods to evaluate mobility requirements and programs in the context of future warfare environments.

2. To determine the state of the art in mobility analysis and modeling and how recent and potential advances in computing environments might be exploited to support future mobility investments decisions.

Process: A read-ahead package and introductory keynote presentation will set the operational context. This will be followed by presentations on various aspects of mobility analysis and modeling along with advances in computing environments with potential application to the mobility area. Participants will discuss these presentations and suggest topics that should be included in a white paper to be written by a working group at the end of the conference.

1. The Workshop will address the following specific aspects of joint mobility analysis:

    A. The status of current joint mobility analysis in an operational context:

    - Day to day operations and training
    - Spectrum of military actions
    - Resource allocation and budgeting

B. Analysis of mobility support for future warfare:

- Changes to strategic mobility
- Changes to tactical mobility

C. Technical aspects of mobility modeling:

- Scheduling algorithms
- Simulation techniques
- Data Management
- Optimization

D. Role of emerging computing environments:

- Potential for advances in hardware/software
- Adjustments for the high level architecture

2. Discussion will start with the status of mobility analysis and identification of potential future requirements. It will then move to more specific technical issues. The following questions will be discussed. Papers addressing these questions will be invited for presentation or pre-distribution.

A. What is the operational context in which mobility analysis is currently used? What can be envisioned to be the changes in requirements in the near and far term? What types of analysis are available and how are they related to real world systems?

B. What aspects of mobility systems are modeled well, poorly, or not at all? What are the desirable aspects of today's mobility models? Which modeling techniques do we want to include in future mobility models? Papers in this area should address deployment scheduling and deployment simulation for both strategic and intra-theater systems.

C. How can new capabilities in programming, modern hardware, and operating systems be used to improve support to mobility analysis and modeling? What new capabilities in mobility analysis are possible in the computing environment that will be available in the next three to five years? Papers in this area could address the potential of object-oriented programming, advances in computing environments, the role of distributed computing, new operating systems, and related topics.

D. How can we build a decision support structure to determine mobility requirements and evaluate mobility programs in the context of future warfare. Papers in this area should help identify and address the challenges future warfare presents to mobility analysis and modeling.

Background: The mobility community has been and is involved in a number of initiatives that seek to move us to the next generation of mobility modeling. These initiatives are described in a document, which will be included in the read-ahead package for the Workshop.

Workshop Structure: The Workshop will be held 26-27 September at MITRE Corporation. Day 1 will start with a keynote presentation on future warfare environments that will frame the workshop activity. Following discussion to clarify and refine this initial presentation, the focus will move to recent and proposed analytic techniques and models, data analysis requirements, and the lift demands of current and future warfare. Day 2 will focus on current and anticipated improvements in the computing environment supporting mobility analysis and modeling and the implications of designing mobility models to a high level architecture. On the third day, 28 September, a smaller working group, representative of the community, will meet to prepare the structure for a white paper that addresses the topics, questions, issues and viable courses of action raised at the workshop.

Product: The Working Groups white paper will define a framework for improving mobility analysis and models in the near-term and propose new analysis and modeling requirements for the future. This paper will be disseminated by bulletin board, e-mail or fax to other workshop participants who will be invited to submit comments within two weeks. The final version of the white paper will be submitted to the Sponsors within one month of the Workshop.

Leadership Structure:

1. The Workshop chair is proposed to be Jim Johnson, Director Projection Forces Division, Program Analysis and Evaluation. Deputies will include Denis Clements (General Research Corporation), (others to be identified from J-4, Transcom, etc).

2. Members of the Working Group responsible for the white paper will be representative of the mobility community.

3. Workshop attendance will be by invitation. Sponsors and Board Members are requested to submit a list of candidate attendees by 25 July.

4. MORS Advisors are Jim Bexfield and Jackie Henningsen.

5. Organizing Committee Members are Jim Johnson (ODPA&E), Denis Clements (OD PA&E), Fred Hartman (ASI), Stu Starr (MITRE), Dick Wiles (MORS), Natalie Addison (MORS), (to be expanded).

Proponents:

The workshop proponent is the Director for Theater Assessments and Planning, Office of the Director, Program Analysis and Evaluation.

Co-proponents are the: The Deputy Under Secretary of the Army (OR); the Director of Modeling, Simulation and Analysis, Deputy Chief of Staff, Plans and Operations, HQ USAF; Director, Assessment Division, OCNO; and The Director for Force Structure, Resource and Assessment, The Joint Staff.

Administration:

Dates: 26-27 September 1995

Location: The MITRE Corporation
                7525 Colshire Drive
                McLean, VA

Fee: $150.00 (Federal Government)
                $300.00 (Others)

Hotel: The McLean Hilton
                7920 Jones Branch Drive
                McLean, VA
                703-847-5000
                Rate of $114.00 inclusive

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